ENTER THE WORLD OF MULTICHANNEL

SURROUND SOUND TECHNOLOGIES

FROM DOLBY LABORATORIES

Dolby

Breaking Sound Barriers

Multichannel audio technologies from Dolby Laboratories have been thrilling viewers with surround sound for more than 25 years.

First there was matrixed, four-channel surround sound from stereo optical movie soundtracks (originally called Dolby Stereo). That technology then migrated into the home as Dolby Surround via stereo VHS video cassettes, laser discs, and TV broadcasts. Tens of millions of home playback systems are now equipped to decode Dolby Surround encoded programs, making it the most widely-used surround technology.

Next came discrete 5.1-channel Dolby Digital, also used first in movie theatres, and now brought into the home via DVD and DVD-ROM, DTV (digital TV), laser discs, digital cable, and satellite systems. The number of DVD players, set-top boxes, surround-sound playback systems, and even PCs with Dolby Digital decoding is already in the millions and is increasing rapidly.

Between Dolby Surround and Dolby Digital, any video or audio-only medium, analog or digital, can deliver surround audio to the consumer. In addition to these consumer surround technologies, Dolby has developed a new professional digital audio coding, Dolby E, specifically for DTV multichannel audio production and distribution.

The technologies in brief

Dolby Surround is a matrix process that enables any stereo (two-channel) medium, analog or digital, to carry four-channel audio. Encoded program material is fully compatible with mono and stereo playback, while listeners with playback systems incorporating Dolby Surround Pro Logic decoding enjoy four-channel surround sound. The two tracks of Dolby Surround encoded programs are identified as Left total/Right total (Lt/ Rt) to differentiate them from conventional stereo Left only/Right only(Lo/Ro) programs. See Figure 1.

Dolby Digital, sometimes known as "AC-3" for the technology on which it is based, is a perceptual coding for consumer applications that enables storing and transmitting from one to 5.1 audio channels at a low data rate. Dolby Digital audio is used for digital television, digital cable, and DBS transmissions, and for DVD and laser discs. See Figure 2.

A unique feature called "downmixing" makes it possible for any consumer playback system with Dolby Digital decoding, regardless of channel configuration, to play 5.1-channel Dolby Digital programs. Mono and two-channel consumer decoders automatically create mono, stereo, or Dolby Surround Lt/Rt mixes "on the fly" from multichannel programs. As a result, the same multichannel Dolby Digital bitstream can be delivered to, and satisfy, all listeners. See Figure 3.

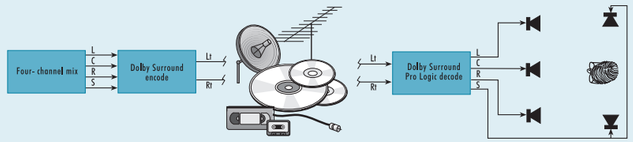

Figure 1: The Dolby Surround format.

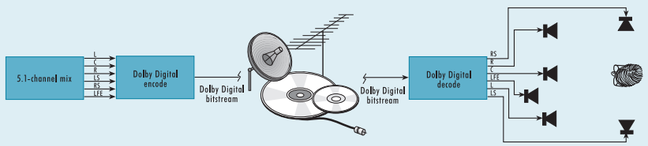

Figure 2: The Dolby Digital 5.1-channel format.
Dolby Digital may also be used to code mono, stereo, and Dolby Surround (Lt/Rt) audio.

Supplementary information known as metadata is added during production, post-production, or transmission to identify a Dolby Digital soundtrack's production format—mono, stereo, matrixed or discrete surround—and ensure proper playback. Other metadata parameters include "dialnorm," which maintains a constant dialogue-keyed playback level for all program material and sources, and "dynrange," which applies a pre-determined amount of dynamic range compression when listening conditions warrant, such as late at night.

Dolby E is a new professional audio coding technology that allows a single AES/EBU audio pair, or a single pair of digital VTR audio tracks, to carry up to eight channels of audio for post-production and distribution purposes. Unlike Dolby Digital, which allows for only one encode/decode cycle, Dolby E, in part because it uses a higher bit rate, allows multichannel programs to be decoded, processed, re-encoded, and edited up to ten times without audible degradation prior to final Dolby Digital encoding and broadcast.

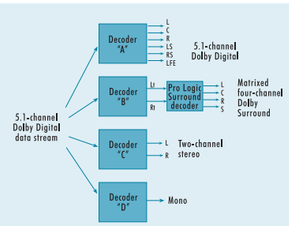

Figure 3: Dolby Digital downmixing.

Surround soundtracks for consumer media

Figure 4 shows which surround technology is appropriate for each medium. Note that Dolby Digital and Dolby Surround are not mutually exclusive technologies, and that the former does not replace the latter. Dolby Surround has the advantage of bringing surround sound to the consumer via any two-channel stereo medium, including Dolby Digital two-channel programs.

Dolby Surround-encoded two-channel (Lt/Rt) Dolby Digital can be used whenever it is impractical to deliver 5.1-channel Dolby Digital, and producers want their programs heard in surround by the millions of consumers who have Dolby Surround playback systems. It is also useful for multiple-soundtrack media such as DVD-Video, wherein a 5.1-channel soundtrack might be provided in one language and a two-channel matrix-encoded soundtrack in another, reserving as much data as possible for the video on the disc. See Figure 5.

Consumer Delivery medium	Two-ch. analog, Dolby Surround encoded*	Two-ch. ATRAC, Dolby Surround encoded*	Two-ch. PCM, Dolby Surround encoded*	Two-ch. Dolby Digital, Dolby Surround	5.1-ch. Dolby Digital encoded*	Notes
Analog stereo TV	x					
FM stereo	x					
VHS tape	x					
Analog cable	x					
"Red Book" CD			x			CDs with other than PCM audio do not meet Red Book standards
Audio cassette	x					
MD		x				
Laserdisc			x		x	PCM track required on all releases; Dolby Digital track is optional.
ATSC digital TV				x	x	Due to consumer decoder downmixing, these media normally do not require a two-channel Dolby Digital mix if 5.1-channel audio is transmitted. See text.
DVB digital TV				x	x	
Digital cable				x	x	
DBS				x	x	
DVD-Video			x	x	x	DVDs can carry multiple soundtracks. Their number and format depends on the particular release. See text.
DVD-Audio					x	

Figure 4: Surround soundtracks for consumer media

Dolby Digital decoding. The vast majority of DVD-Video discs, therefore, are being released with at least one Dolby Digital soundtrack, and in many instances, only a Dolby Digital soundtrack.

DVD-Audio soundtracks

In version 1.0 of the recently completed DVD-Audio specification, the optional video zone of the DVD-Audio disc must conform to the DVD-Video disc specification. If you intend to use this option to

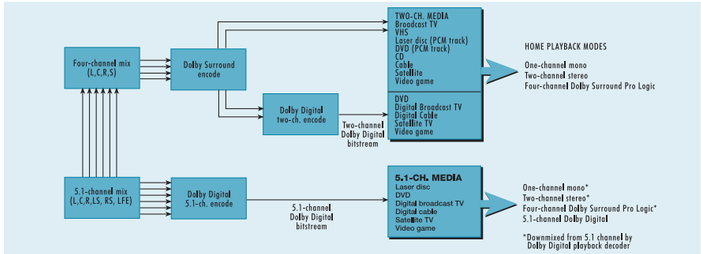

Figure 5: Multichannel program preparation.

DVD-Video soundtracks

Dolby Digital is a mandatory audio coding for DVD-Video, meaning a Dolby Digital-coded soundtrack (mono, stereo, Dolby Surround-encoded two-channel, or 5.1-channel) can be the only one on a disc. A track using an optional coding can be provided only in addition to a mandatory track.

Dolby Digital is the only mandatory multichannel coding in NTSC countries, and one of two mandatory multichannel formats in the rest of the world, including Europe (see Figure 6). In addition, all DVD-players worldwide are equipped for insure compatibility with all existing DVD-Video players, you should include either a Dolby Digital 5.1 (if your program is multichannel) or PCM two-channel audio track.

Because of its low bit rate, it is easy to include a Dolby Digital version of the program, in addition to the high-quality PCM and/or Meridian Lossless Packing (MLP) versions that reside in the audio zone on the same disc. Doing so enables the discs to play on any of the millions of DVD-Video players in use, as well as DVD-Audio and "combi" players as they become available.

Disc Specifications for Audio Coding for DVD-Video

	NTSC Disc	PAL/SECAM Disc
MANDATORY	*Either of the following:*	*Either of the following:*
	Linear-PCM (2-ch.) or Compressed audio • Dolby Digital (1–5.1-ch)	Linear-PCM (2-ch.) or Compressed audio • Dolby Digital (1–5.1-ch.) • MPEG-1 LII (2-ch.) • MPEG-2 LII (multichannel)
OPTIONAL	*Any of the following:* • Dolby Digital (1–5.1-ch) • DTS (1–5.1-ch.) • Linear-PCM • MPEG (1–7-ch.) • SDDS (1–7.1-ch.) • Others	*Any of the following:* • Dolby Digital (1–5.1-ch) • DTS (1–5.1-ch.) • Linear-PCM • MPEG (1–7-ch.) • SDDS (1–7.1-ch.) • Others

Figure 6: Digital audio types used on DVD-Video discs.

DVD-ROM

Dolby Digital is now migrating to the PC platform as DVD-ROM drives become increasingly popular. While the demand for the new drives has been driven initially by the desire to play back DVD-Video discs on PCs, software developers are now starting to support Dolby Digital 5.1 for their DVD-ROM game and multimedia titles.

Multichannel audio is an ideal enhancement to interactive entertainment, and Dolby Surround sound is already featured on over 200 games for the PlayStation, Nintendo 64, Sega Dreamcast, and CD-ROM formats. The added excitement of discrete 5.1-channel Dolby Digital in increasingly sophisticated PC sound cards and speaker systems is quickly becoming established as a significant new entertainment product category.

About DTV audio and Dolby E

Dolby Digital is optimized for the efficient delivery of audio to the end listener, maintaining high quality through one encode (transmission) and decode (reception) cycle. It has not been designed to withstand the multiple encode/decode cycles usually required in the production, post-production, and distribution of audio destined for DTV prior to transmission.

Moreover, Dolby Digital audio frames (32 ms) do not match video frames, making it impractical to edit programming with Dolby Digital encoded audio. As a result, Dolby Digital encoding must be the last step prior to transmission, with some other audio format (analog or digital) used up until that point. This also holds true for DTV formats that use other perceptual audio coding systems, such as MPEG.

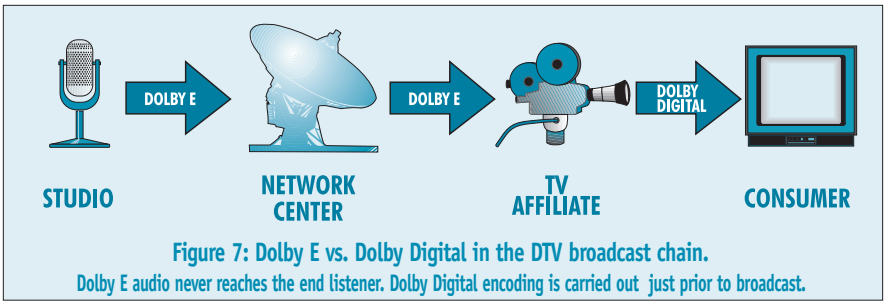

Figure 7: Dolby E vs. Dolby Digital in the DTV broadcast chain.
Dolby E audio never reaches the end listener. Dolby Digital encoding is carried out just prior to broadcast.

Because few TV production and broadcast facilities are equipped to handle multichannel PCM audio without major modifications, Dolby Laboratories has developed a new professional digital coding, Dolby E. It allows a single AES3 pair, or a single AES pair that can be recorded by a digital VTR or video server, to carry up to eight channels of audio plus Dolby Digital metadata. As a result, many facilities can convert to multichannel audio simply by wrapping Dolby E encoders and decoders around their existing digital audio distribution systems (see sidebar on Dolby professional audio products).

With a sophisticated algorithm and low compression ratio, Dolby E signals can withstand 10 or more tandem encode/decode cycles without audible degradation. In addition, Dolby E audio frames match video frames, facilitating smooth transitions during audio-follow-video editing in the digital domain. Dolby E, therefore, is an ideal "distribution" audio coding for the production of programs destined for DTV, while Dolby Digital's low data rate makes it an ideal "emission" coding. See Figure 7.

Delivering a completed mix

Two-channel, matrix surround-encoded (Lt/Rt) mixes can be delivered to the client in exactly the same way as a conventional stereo mix: on any two-track audio tape, two tracks of a multichannel audio tape, or two audio tracks of a video tape.

Discrete 5.1-channel mixes are often delivered on separate eight-channel audio tape such as the TASCAM DA88. For soundtracks ultimately intended for DTV broadcast, it is preferable to deliver the mix in Dolby E encoded form recorded onto two tracks of a digital audio or video tape.

Mixes for DVD authoring

Originally Dolby Digital multichannel encoders were expensive, so that only fully-equipped DVD authoring facilities were able to handle the mastering of a multichannel surround mix to a 5.1-channel Dolby Digital bitstream. While the option remains for content providers to deliver their discrete multichannel mixes to such facilities, they now have the option of authoring Dolby Digital soundtracks complete with metadata in-house. The availability of low-cost Dolby Digital codecs and software utilities makes it possible to record Dolby Digital (.ac3) files on Windows 95/NT computers equipped with a digital I/O sound card (see sidebar on Dolby professional audio products).

More information

For more information, visit www.dolby.com. See "Technical Information," for appropriate articles including:

- Guidelines for Producing Music in 5.1-Channel Surround
- Dolby Digital Broadcast Implementation Guidelines
- Dolby Digital Professional Encoding Manual
- Dolby Surround Mixing Manual
- Dolby E Multichannel Coding for DTV Audio Production and Distribution

DOLBY PROFESSIONAL PRODUCTS

Dolby Surround

SEU4 Dolby Surround Encoder
For encoding four-channel programs (L, C, R, and S) into Dolby Surround (Lt/Rt) format for use on any two-channel medium including broadcasts, ad spots, videos, TV shows, CDs, and video games.

SDU4 Dolby Surround Decoder
Professional reference Dolby Surround decoder for broadcast, post production, game developers, and music facilities. Features mode switching to check compatibility with mono, stereo, and Dolby Surround playback.

Dolby Surround Tools
Encoder and decoder TDM Plug-Ins for Dolby Surround mixing and "4-2-4" monitoring on Digidesign® Pro Tools® workstations. Features surround panners, game mode options, and mono, stereo, and surround monitoring.

Dolby Digital

DP569 Multichannel Dolby Digital Encoder
Reference Dolby Digital encoder for DTV broadcasting, digital cable, DBS, and DVD and laser disc mastering. Supports bit rates from 56 to 640 kb/s for one to 5.1 channels.

DP562 Multichannel Dolby Digital Decoder
Multichannel reference decoder for all Dolby Digital formats including 5.1-channel DVD and laser disc audio, DTV, digital cable, and DBS, plus digitally-implemented four-channel Dolby Surround Pro Logic decoding.

DP567 Dolby Digital Encoder
Two-channel Dolby Digital audio encoder for digital TV broadcasting, cable, DBS, and DVD authoring. Stereo mode preserves matrix encoding on Dolby Surround input signals.

Software utilities
Dolby Digital Recorder is used in conjunction with the Dolby DP569 and DP562 units and a Windows 95/NT computer equipped with a digital I/O soundcard, to author the Dolby Digital (.ac3) files for DVD release.

Dolby Remote is used in conjunction with a Windows 95/NT computer to remotely control the Dolby DP569, DP567, and DP562. This utility can be used in all applications from broadcasting to disc authoring.

Dolby E

DP571 Dolby E Encoder
Accepts up to eight channels of digital audio and Dolby Digital metadata and outputs a Dolby E–encoded AES3 bitstream that can be stored and carried through the two-channel broadcast infrastructure.

DP572 Dolby E Decoder
Accepts a Dolby E–encoded AES3 signal and outputs up to eight channels of digital audio and Dolby Digital metadata.

Dolby Laboratories Inc • 100 Potrero Avenue, San Francisco, CA 94103-4813 • Telephone 415-558-0200 • FAX 415-863-1373
Wootton Bassett, Wiltshire, SN4 8QJ, England • Telephone (44) 1793-842100 • FAX (44) 1793-842101 • www.dolby.com

Dolby and the double-D symbol are trademarks of Dolby Laboratories © 1999 Dolby Laboratories Inc S99/12377